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[EA]Scoring System as a Quick and Objective Method to Conclude Fluid Analysis (Gas/Water Reservoir), and Standardization of Fluid Identification*

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Abstract

Formation fluid identification (gas, oil, and water) is a crucial component of reservoir characterization to build geological modeling, presence of formation water and significant information in defining field development/perforation strategy. The fluid analysis (FA) tool has been used as the standard logging tool for formation fluid identification. This fluid analysis tool consists of many sensors inside (Density, Capacitance, Pressure, and Resistivity). Base on these sensor and other parameter given, we can interpret the fluid at the real time operation, but also sometimes the information can give us the ambiguities or inconsistency result. The inconsistency of information caused by several factor: mud filtrate, mix fluid in that reservoir, gas water contact, the sensor is plugged by debris, low permeability, insufficient pumping time, different interpreter.

Discussion

In-house fluid scoring system has been developed, giving weight for each data or information that delivered by all sensors and parameters and applicable mainly for Gas and Water identification. In this methodology, 7 classifications with specific cut off value are used to create scoring for final fluid interpretation; density while pumping - segregation, capacitance, resistivity while pumping – segregation, compressibility, and pumping pressure trend. The objectives are to establish reliable scoring system to conclude fluid analysis and standardize the fluid ID identification by all interpreter and consistency result in database.

This methodology has been tested in delta Mahakam since 2014 with more than 300 FA data and the accuracy is 95% (Figure 1). This scoring system is use specifically for gas and water reservoir only. Starting 2016, it has been systematically implemented to classify formation fluid for all fields. It is very helpful, powerful to have standardization in real-time operations, and at the end to minimize the uncertainties of the interpretation.

Wireline formation tester (WFT) is one of the important regular logging jobs in Mahakam Delta wells, where almost all wells will have this acquisition to provide accurate formation pressure and fluid identification. WFT tool is deployed into open hole and set in front of the reservoir target. Pressure test will be done first and followed by fluid analysis which pumping formation fluid inside the tool's flow line. This technique is reliable and robust but could lead to misinterpretation or inconsistent interpretations due to various sensors used and expertise of the interpreter. Those can lead to confusion and difficulty to identify reservoir fluid. This challenge has encouraged us to develop a new method that statistically analyzed all sensor and parameter inside WFT tool which is simple, quick, cheap, and without any additional sensor.

The section of pressure gauge consists of three piezoelectric quartzdyne crystals that generate electric waves depending on the temperature and pressure. One crystal measures the pressure from the formation, and the other two correct the readings. Additionally, one crystal measures the temperature, and the other is the reference crystal. The resolution of the pressure reading is 0.001 psi with 0.01% accuracy.

The section fluid analyzer consists of several sensors that are crucial for fluid identification. The density sensor consists of a tube filled with fluid that vibrates (Figure 2) at specific frequencies related to the density of the fluid. The resolution of the density sensors is 0.001 g/cm^3 with an accuracy of 0.01 g/cm^3

The capacitance sensor measures the ability of the fluid to store electric charges. Two capacitance sensors are included in the fluid analyzer section: the numar and the spiral. The resistivity sensor (Figure 3) measures resistivity fluid inside flowline, mud filtrate, or reservoir fluid.

The fluid analysis scoring system has considered all sensor response to formation fluid while pumping and segregation. More than 300 FA data has been used (2014-2015) with accuracy 95%. 7 main parameters have been used to define fluid status (Gas/Water) with specific cut off value for each sensor: fluid density, capacitance, resistivity, flowing pressure, compressibility (Table 1).

By using the fluid scoring system, formation fluid can be classified into 7 fluid scoring parameters (Table 2).

Conclusions

Reservoir fluid gas and water will always show its own characteristics respect to sensor reading. However, in the mature field and highly produced, the water rise issue can make a mixed fluid detected during logging with FA tools. This scoring system is developed to provide reliable and robust methodology to conclude fluid that is detected by the FA tool. The 7 parameters have been used objectively, and considering each parameter has the same weight with specific cut off values. The scoring system is applicable for all PHM fields in the Mahakam delta. This scoring system serves as quick and objective method to conclude Fluid Analysis (Gas/Water reservoir), and standardization of fluid identification**.**

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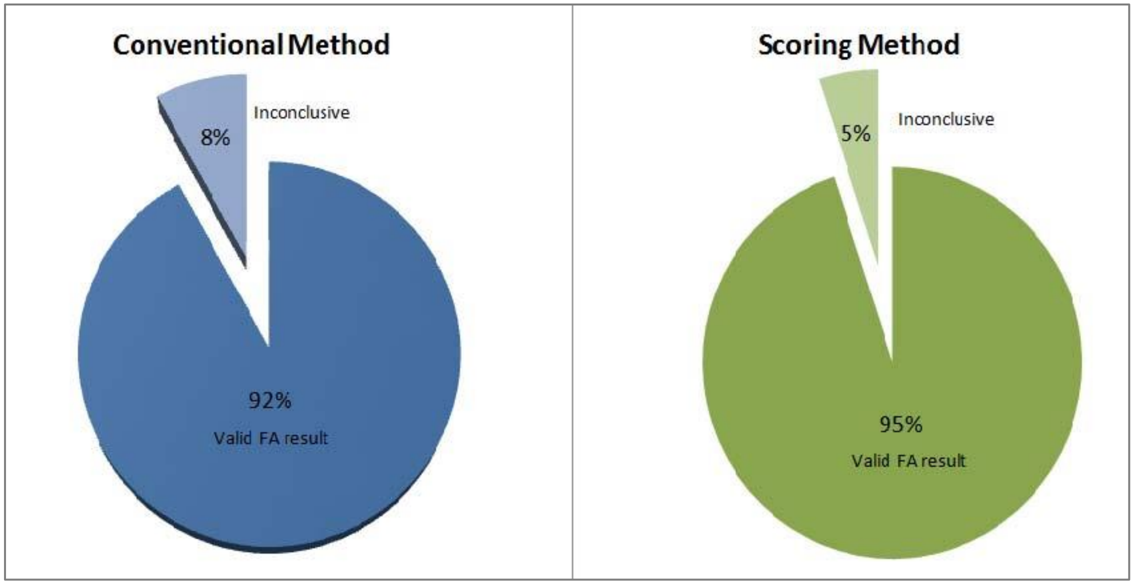

Figure 1. Increasing accuracy of Fluid Analysis interpretation.

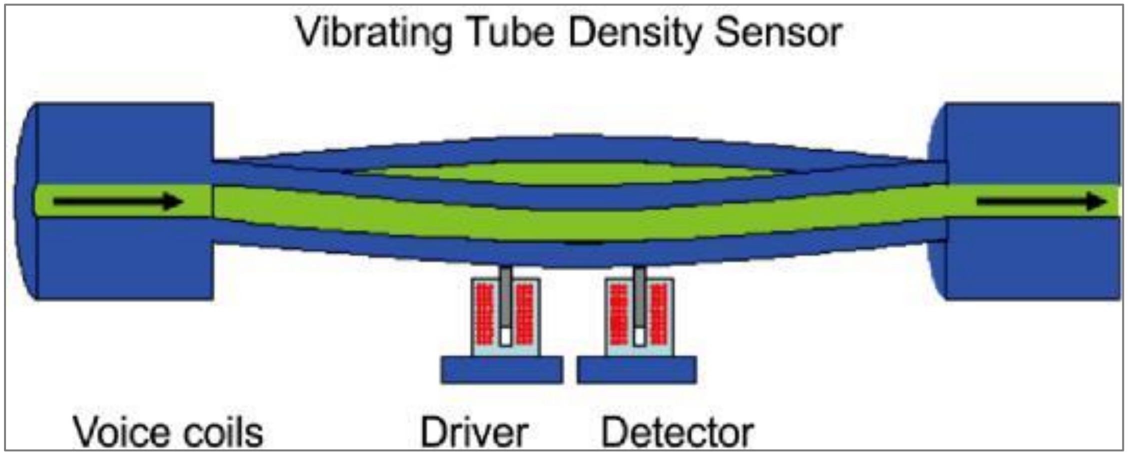

Figure 2. Vibrating tube (Gao et al., 2009).

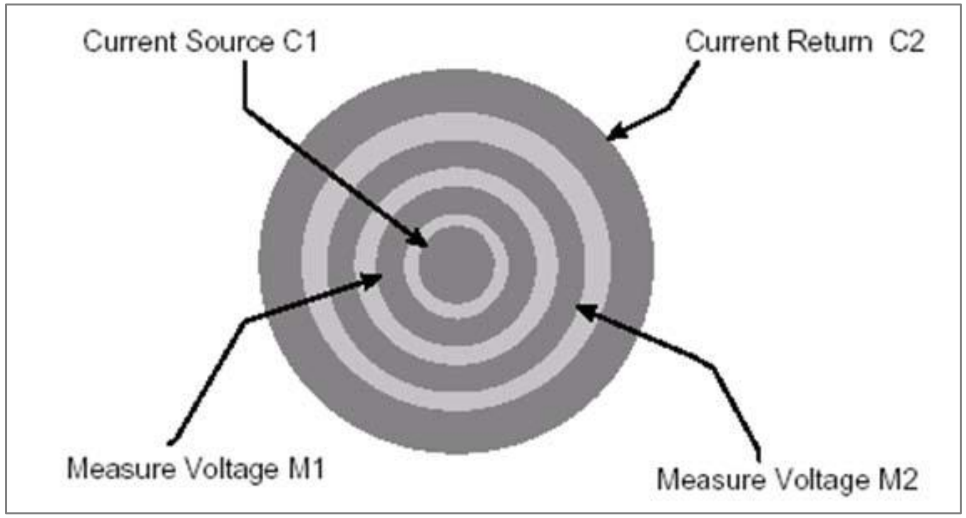

Figure 3. Resistivity sensor.

FLUID ID SCORING		
(1) Minimum density while pumping	<0.46 gr/cc	1
	>0.46 gr/cc	0
(2) Maximum density while pumping	<0.84 gr/cc	1
	>0.84 gr/cc	0
(3) Maximum capacitance while pumping	<40 pF	1
	>40 pF	0
(4) FLID resisitivity while pumping	no show	1
	show	0
(5) FLID resisitivity while segragation	no show	1
	show	0
(6) Compressibity	> 70 ppm/psi	1
	≤70 ppm/psi OR bubble point test not performed	0
(7) Pumping pressure	Up/Stable	1
	Down	0

Table 1. Fluid Scoring Parameters.

SCORE	
GAS	7
GAS/ GAS WITH RESISTIVITY RESPONSE	6
GAS WITH POSSIBLE WATER	5
GAS WITH WATER	4
WATER WITH GAS	3
WATER WITH POSSIBLE GAS	2
WATER	0-1

Table 2. Fluid ID based on scoring classification.